Modeling and Simulation Education at AFIT

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Department of Operational Sciences
Air Force Institute of Technology

Overview

- AFIT M&S Involvement
- Department of Operational Sciences
  - Programs
    - MS
    - PhD
  - Research
  - Consulting

AFIT does MS&A

- Operational Sciences
  - Operations Research
  - Operational Analysis
- Computer Science/Engineering
- Electrical Engineering
- Aeronautical Engineering
- Meteorology
- Others

Department of Operational Sciences

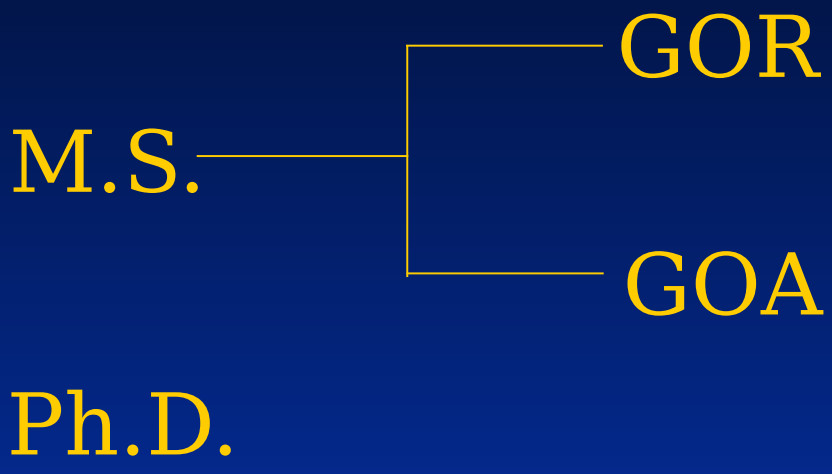
Supporting Modeling, Simulation and Analysis through graduate education programs, research, and consulting.

Department Overview

- Modeling and Simulation Education
- Faculty
- Research and Consulting

Supporting the AF M&S Mission

Educational Programs



Operations Research Program

GOR: Graduate Operations Research
Theory and practice of Operations Research with emphasis on application to solving complex problems

61S3A AF specialty code
0YEY academic specialty code

Operational Analysis Program

GOA: Graduate Operational Analysis
Application of OR techniques to operational problem-solving and decision-making

various AF specialty codes
0YSY academic specialty code

M&S Core Curriculum

Linear Programming
Network Flows

Probability and Statistics
General Linear Models
Object-Oriented Simulation

Broad Exposure to Modeling, Simulation, and Analysis Techniques (First 3 Quarters -- 9 months)

Combat Modeling
Mathematics
C++ Programming

Specialty Coursework

Integer Programming
Scheduling Theory
Non-linear Programming

Decision Analysis
Applied Stochastic Processes
Queueing System Analysis

Supporting Coursework for Thesis Research and Specialization Sequence (2nd 3 Quarters - 9 months)

Joint Combat Modeling
Joint Mobility Modeling
Weapons Effects

Response Surface Methodology
Applied Multivariate Analysis
Quantitative Forecasting

Advanced Simulation
Virtual Environment
3-D Computer Graphics

Thesis

- Description:
  - 6 months of intensive effort (12 quarter hours)
  - Supervised & evaluated by faculty committee
  - Culminates with formal document & defense
  - Most sponsored by DoD organizations
- Benefits to Sponsors:
  - Addresses important issues or problems
  - Excellent for prototype / proof-of-concept
  - Incoming graduates “hit the ground running”
  - Quality product at an affordable price

PhD Resident Program

- One Year of Academics:
  - Specialty Area (24 quarter hours)
  - Minor Area (12 quarter hours)
  - Mathematics (12 quarter hours)
  - OR Core (12 quarter hours)
- Exams:
  - Specialty, Minor, & Math
  - Prospectus & Dissertation Defenses
- Two Years of Dissertation Research

Faculty Background

Faculty Member	*Ph.D.*	*Research Interests*
Col John Andrew *	Harvard	Training simulations, stoch proc
Lt Col Glenn Bailey**	Texas	Simulation, RSM, heuristics
Dr. Kenneth W. Bauer	Purdue	Simulation, neural nets, multiv.
Dr. Yupo Chan	MIT	Transp. systems, networks
Dr. James W. Chrissis **	Virginia Tech	Optimizatio
Dr. Richard F. Deckro	Kent State	Optimization, IO/IW, MCDM
Maj Mark Gallagher	AFIT	STRATCOM
Maj Raymond R. Hill	Ohio State	Simulation, optimization, heuris
LTC Jack M. Kloeber	GA. Tech	DA, simulation, neural nets
Capt Jeff Lanning	Arizona St.	Statistics, reliability
Lt Col Greg McIntyre	George Mason	Heuristics, combat modeling
Lt Col J. O. Miller	Ohio State	Simulation, ranking and selecti
Dr. James T. Moore	Texas	Mobility, scheduling, heuristics
Maj W. Paul Murdock	Virginia Tech	Stochastic processes, reliability

* Head ** Deputy Heads

Faculty Background

- Operational Experience:

  Aircrew, Missile Ops, Space Ops, Artillery

- Staff Experience:

  Joint Agencies, Air Staff, MAJCOM HQs, AFMC Acquisition Centers, T & E Centers

- Recent Funded Research Sponsors:

  AFOSR, C-17 SPO, DoE, Joint Depot Maintenance Analysis Group, SWC, NSA, GM, PepsiCo

- Other Recent Research Sponsors:

  ACC, AFMC, AFOTEC, AF Information Warfare Center, AFSAA, AF/PEY, AMC, ARPA, CENTCOM, INSS, NASA, STRATCOM, USAFE, AFRL

Publications

✓ In the past five years we've published over 50 separate articles

✓ Research primarily from master's theses and Ph.D. dissertations

✓ Additional support from faculty consultations and outside projects (Air Force 2025)

- *Management Science*
- *Operations Research*
- *Naval Research Logistics*
- *Simulation*
- *European Journal of Operations Research*
- *Omega*
- *Computers and Industrial Engineering*
- *Military Operations Research*
- *Annals of Operations Research*
- *Structural Optimization*
- *Mathematical and Computer Modelling*
- *Interfaces*
- *Asia-Pacific Journal of Operations Research*
- *Proceedings of the Winter Simulation Conference (1993-1997)*

Research

- ✓ Since 1993, we've received over $1,500,000 in research funding

- ✓ Air Force, DoD, non-DoD Federal agencies, and private-sector organizations via CRDAs.
  - *Object-Oriented Simulation of C-17 Airborne Operations* ***(C-17 SPO)***
  - *C-17 Airlift Loading Model Using Java* ***(AF Studies and Analyses Agency)***
  - *Development of Planning Tools for JFAC Planning Cell* ***(ACC)***
  - *Improving Information Network Performance* ***(NSA)***
  - *Analysis of Tier2+ and Tier 3 High Altitude UAVs* ***(C-17 SPO)***
  - *Data Envelopment Sensitivity Analysis* ***(U.S. Army Recruiting Command)***
  - *Evaluation Procedures for Automatic Target Recognition*

M & S Education at AFIT

Specialty Sequences

- Operational Effectiveness:
  - Combat Modeling I
  - Weapons Effects (nuclear/conventional)
  - Comm, Command & Control of EW
  - Cost Analysis

Specialty Sequences

- Modeling and Simulation:
  - Combat Modeling I
  - Combat Modeling II
    or
    Joint Mobility Modeling
  - Computer Communication Networks
  - Databases

Research Focus

- Operational Modeling, Simulation & Analysis
  - Customer-focused research applying state-of-the-art mathematical and computing methodologies to the solution of operational problems
  - Support better decision-making, planning, and scheduling in complex operational, command, and control systems
  - Enhance the Air Force's MS & A capabilities

Research Areas

- Simulation, Operational Modeling & Analysis
  - Joint Combat / Joint Operations Modeling
  - Mobility & Transportation Modeling
  - Simulation Model Development
  - Simulation Input & Output Analysis
  - Information Operations/Warfare
  - Wargaming

Research Areas

- Empirical Modeling & Analysis
  - Experimental Design & Response Surface Methodologies
  - Multivariate Statistical Analysis
  - Neural Networks
  - Forecasting / Time-Series Analysis
  - Statistical Process Control & Capability Analysis
  - Spatial-Temporal Modeling

Research Areas

- Mathematical Modeling & Optimization
  - Scheduling, Planning & Resource Allocation
  - Linear, Nonlinear & Integer Programming
  - Network Modeling, Optimization & Analysis
  - Large-Scale Optimization
  - Algorithm Development
    - Including Genetic Algorithms, Simulated Annealing, and Parallel Processing

Research Areas

- Probabilistic Modeling & Analysis
  - Decision & Risk Analysis
  - Stochastic Processes, Queueing Models
  - Stochastic Programming
  - Stochastic Scheduling
  - Reliability Analysis